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*XXIII. Farther Observations on the Effects which take Place from the Destruction of the Membrana Tympani of the Ear; with an Account of an Operation for the Removal of a particular Species of Deafness. By Mr. Astley Cooper. Communicated by Everard Home, Esq. F. R. S.*

Read June 25, 1801.

IN the Paper which I had last year the honour of presenting to the Royal Society, I endeavoured to point out the effects which are produced upon the organ of hearing, by a partial loss, or entire destruction, of the membrana tympani.

From the facts therein detailed it appears, that an aperture in the membrana tympani does not diminish the power of the ear, and that even a complete destruction of the membrane is not followed by a total deprivation of the sense of hearing; a supposition which medical men have adopted, and common opinion has generally sanctioned.

Convinced of the importance of the subject, and desirous, as far as my other avocations would allow, of pursuing my inquiries, I have, since the publication of that Paper, examined more than twenty cases of a similar defect in the membrana tympani; and these instances have uniformly tended to confirm me in my former opinion, as to the use of the membrane, and the effects which follow from its loss.

Injury may arise to the membrana tympani, or its destruction take place, from various causes, of which the most common is,

a suppuration in the meatus auditorius. In persons of a delicate constitution and irritable habit, the wax secreted in the ear is liable to be hardened ; this, by filling the meatus auditorius, gradually occasions deafness, and then excites inflammation and suppuration. In this case, if no mode of relief be resorted to, not only will the membrane lining the meatus, but also the membrana tympani itself be destroyed, the small bones of the tympanum discharged, and sometimes considerable exfoliations produced.

The membrana tympani is also not unfrequently injured by means of external violence. In Plate XXXIII. Fig. 4, a view is given of the membrane lacerated in different directions, by a blow upon the side of the head ; an effect which probably was occasioned by the air in the meatus having been driven with violence upon the membrane.

The membrana tympani is also sometimes broken by attempts to remove extraneous bodies, which have been thrust into the meatus auditorius. Children, in their thoughtless pranks, often introduce small stones, pieces of slate-pencil, and even pins into their ears ; in extracting which, I have known considerable lacerations made in the membrana tympani. Fig. 5, shews the membrane broken perpendicularly, in an attempt to remove a pin, which had been accidentally dropped into the meatus.

The membrana tympani may be easily seen in some persons, by directing the rays of the sun, or a condensed light from a common lamp, into the ear ; but this is not the case in all ; for the meatus differs considerably in different persons, both in its depth and diameter.

If the ear is clear from wax, the membrane has a bright tendinous appearance ; and an aperture in it appears as a dark

spot, which, by the silvery surface of the membrane surrounding it, is rendered distinctly perceptible. If there be an aperture, air also, upon blowing the nose with violence, will be forced with a whistling noise through the ear. The smoke of tobacco may be driven from the mouth through the ear; or water may be injected from the ear into the throat.\*

The effect produced upon the sense of hearing, by this defective state of the membrana tympani, varies according to circumstances. If there be a small aperture only, leaving the malleus with its natural attachment, no difference in the power of the organ is perceptible; the membrane vibrates, and communicates its vibrations, as before. If the whole of the membrane be destroyed, and three out of four of the small bones of the tympanum be removed, an almost total deafness ensues; but the ear, after a time, begins to recover its powers, and, in the end, regains them, with that degree of imperfection only, which, in my former Paper, I have described in the case of Mr. P——.† The following fact appears to confirm the truth of this statement. Mr. RADFORD, surgeon, of Newington Butts, informs me, that in the year 1779, he attended a woman who had an ulcer in the throat, by which a portion of the palate was destroyed, and the tonsils and Eustachian tube so much injured, that in the attempt to swallow, a part of the liquid ran through her ears; yet, notwithstanding these ravages, she neither complained of any defect in her hearing, nor had the slightest appearance of deafness. In cases, however, where the discharge of matter which pro-

\* It was formerly supposed, that there was naturally a communication between the external ear and the throat, through the membrana tympani; an opinion which it is now almost unnecessary to say is without foundation.

† Vide *Philosophical Transactions* for 1800, page 152.

duced the destruction of the membrane continues, should a fungus arise on the periosteum of the tympanum, or exfoliation of the bones forming this cavity occur, and more especially should the stapes separate, very considerable deafness will be the consequence.

When the membrane of one ear only is destroyed, a greater degree of deafness takes place in that ear, than would happen in either, were the membrane destroyed in both. This, as I stated in my former Paper, probably arises from the disuse into which the imperfect ear falls, from its being less quick in its powers than the other; a conjecture which seems to be verified by the following fact.

Mr. G——, a merchant in the city, lost, at an early period of life, so great a portion of the membrana tympani of the left ear, that no more of it remained than appears in Fig. 3; and, as he heard somewhat better with his right ear than with his left, he was little in the habit of employing the latter, and considered himself at length as almost totally deaf in it. Becoming, however, in the month of December last, deaf in the right ear, and being obliged, in consequence, to employ the other, he found that the left ear was by no means deprived of its powers; although he could force air from his mouth through that ear, and, if he suddenly thrust his finger into the meatus, the air was heard to rush through his nostrils.

I feel a hope that the foregoing observations will tend to something more than merely to gratify curiosity, and will be productive, in the end, of lasting benefit; for they have induced me, in one species of deafness, to try the effect of an operation, which has, in several instances, proved successful.

The deafness to which I allude, is that which arises from an

obstruction of the Eustachian tube; and the operation consists in puncturing the membrana tympani.

The tympanum of the ear is formed like a drum; and, as a drum will produce very little sound, unless air be admitted by a hole in its side, so, in the usual state of the ear, the membrana tympani cannot perform its office, if air has not free access to the cavity of the tympanum. The air, thus essential to hearing, passes from the throat to the ear by the Eustachian tube; so that the membrana tympani is placed between two portions of air, the one contained in the meatus, the other in the cavity of the tympanum. Accordingly, if the Eustachian tube becomes obstructed, the air confined in the tympanum being unable to yield, the membrana tympani must cease to vibrate; and thus, sound being no longer conveyed to the interior parts of the organ, a permanent deafness must ensue.

There are several causes by which a closure of the Eustachian tube may be produced.

It may arise, first, from a common cold affecting the parts contiguous to the orifices of the tube, and thereby preventing the free passage of air into the tympanum. The deafness thus produced, however, is often merely temporary. But the frequent recurrence of such attacks may produce permanent enlargement of the tonsils, which, by their pressure on the Eustachian tubes, will occasion a permanent deafness.

In February last, an instance occurred, of a person who had thus been rendered deaf since the year 1793; and I have met with another instance of deafness from a similar cause.

Secondly, The scarlet fever occasions ulcers in the throat, which, in healing, frequently close the Eustachian tubes, thereby producing lasting deafness.

As this fever occurs particularly in young persons, who are but little subject to a defective state of the nerves of the ear, the greater hope of relief may be entertained from the operation already mentioned.

Thirdly, A venereal ulcer in the fauces, by the cicatrix it produces, often occasions a closure of the Eustachian tube, causing a deafness which nothing but the operation here spoken of can relieve.

Fourthly, I have known this closure of the tube produced by an extravasation of blood in the cavity of the tympanum.

Lastly, I have seen one instance of a stricture in the tube, which, although it did not entirely obstruct the passage of the air, yet rendered it extremely difficult. To enable himself to hear, the gentleman who was the subject of this disease, was under the necessity of forcing air, from the mouth, into the cavity of the tympanum, which pushed the membrana tympani towards the meatus ; then, pressing gently upon the ear, he forced out a part of the air which the tympanum contained ; thus giving the membrane liberty to vibrate, and producing an immediate increase in the power of hearing.

The above mentioned are the most common causes of the closure of the Eustachian tube ; and I have reason to think, from the experience I have already had, that they may all be remedied by puncturing the membrana tympani.

I was led to this operation by reflecting that, as an aperture in this membrane did not appear to injure the power of the ear, and a small opening would be sufficient to admit a free passage of air to and from the tympanum, perhaps a substitute might be thus easily found for the Eustachian tube, and the membrane, by such an aperture, be restored to its natural functions. Oppor-

tunities were soon afforded me of trying the effects of this operation, and of putting my idea to the test of experiment. Of the instances by which it has been verified, the following appear to me most worthy of selection and record.

CASE 1. A woman about thirty-six years of age consulted me, in December last, respecting some disorder in her child. In attempting to converse with her, I found her so extremely deaf that it was with difficulty I could make her hear me. Questioning her upon the subject of her deafness, she informed me that she had been thus afflicted since the year 1793; and I found that it had arisen from the tonsil glands becoming enlarged by a cold, which she caught in the winter of that year. As she was anxious to be relieved, I immediately punctured the membrane of the left ear, being that in which the hearing was most defective. The operation was no sooner performed, than, to my great joy, and of course to hers, I found that, in that ear, she could hear what I said to her, without any particular exertion on my part to speak loud. She staid with me about half an hour; and, when she left me, was capable of hearing every thing that was said in the ordinary tone of conversation.

CASE 2. ANN DALEY was admitted under my care, in Guy's Hospital, on the 21st of January, 1801. She was so deaf that, unless words were spoken close to her ear, it was impossible to make her hear them. She had been thus far deprived of hearing for the space of six weeks; and the deafness had been occasioned by some ulcers which had existed in the fauces. On the 25th of January, four days after her admission into the hospital, I punctured the membrana tympani of the left ear; having previously taken care (the better to ascertain the effects of the operation) to hold a watch to the ear of the patient, the beating of

which she could not distinguish, unless it was pressed against her head. After the operation, I instantly repeated that experiment, and found that, with the ear I had punctured, she could distinctly hear the watch, though it was held at the distance of several feet; whereas, with the opposite ear, she was still unable to hear it beat, unless, as before, it was pressed against her head. Mr. STOCKER, apothecary to the hospital, witnessed the effects of this operation.

On the 28th of the same month, I performed the same operation on her right ear, in the presence of several medical gentlemen, who satisfied themselves as to the cause and degree of her deafness; the ear upon which I first operated having been purposely closed. As soon as the puncture was made, the trial with the watch was again resorted to; and she could hear it beat at the same distance as with the other ear; and could hear us speak, in the common tone of voice, as distinctly as we could hear one another.

To ascertain with certainty whether she really heard the beating of the watch, I placed it at a considerable distance from her, and asked her if she still heard it. To which she answered, "Yes, perfectly." I then stopped the watch, without her knowing it; and, the question being repeated, she listened for a while, then said, "I must have been deceived, I do not hear it:" but, the moment I set it again in motion, she called out, "I hear it now, and as well as I ever did in my life." In this state her hearing continues; the deafness having never, at any time, returned.

The cause of this deafness was obviously in the throat. The disease had not existed sufficiently long to produce any other derangement in the ear; and the good effect of the operation

was therefore so immediately apparent, that it could not be doubted by the most sceptical observer.

CASE 3. MR. ROUND, of Colchester, consulted DR. BAILLIE respecting his son, MR. JOHN ROUND, aged 17, who had laboured, from his birth, under such a degree of deafness as would have incapacitated him from engaging in business. DR. BAILLIE, having satisfied himself that there was no nervous defect in the ear, referred him to me. I found that this gentleman had been born with an imperfect state of the fauces, which rendered him incapable of blowing his nose; that the Eustachian tubes had no openings into the throat, and, therefore, that he was unable to force air from the mouth into the ear. The auditory nerves, however, were perfect; for he could distinctly hear the beating of a watch, if placed between the teeth, or against the side of the head; and he never had perceived any buzzing noise in his ears. I therefore advised him to submit to the operation of perforating the membrana tympani; to which he cheerfully consented. The moment this was done, a new world was opened to him; and the confusion produced by the number of sounds which immediately struck his ear, made him sink upon a chair, almost in a fainting state. From this state he recovered in about two minutes; and, finding that his hearing was completely restored upon the one side, he wished the operation to be performed upon the other; which was immediately done, with the same happy result, and without his experiencing the same confused sensation as before.

Near two months after the operation, I had the pleasure to receive an assurance from him, that he had suffered no relapse, nor any inconvenience from the opening which I had made, and that his hearing continued perfect.

CASE 4. Mr. BRANDON, of Upper Clapton, sent a person to me in January last, who had received a blow upon his head, which had occasioned symptoms of concussion of the brain, and was attended with a discharge of blood from each ear. From the effects which the blow had occasioned on the brain, he speedily recovered; but the deafness, which had immediately followed from the accident, continued. I cleared the meatus from the blood it contained, without any relief being derived to the patient; and, suspecting that a quantity of blood was lodged in the tympanum, and the vibration of the membrane thus prevented, I some days after punctured the membrana tympani. Upon withdrawing the instrument, some dark-coloured blood appeared on its point; and, whenever I examined his ear afterwards, there was the same appearance of blood mixed with the wax of the ear, which continued to discharge for about ten days after the operation, during which period the hearing was gradually restored. I have formerly known instances of permanent deafness from this cause; and I think it not improbable that the blood thus effused has become organised, and continued to fill the cavity of the tympanum.

The operation to remedy the species of deafness here described, consists in passing into the ear a canula, of the size of a common probe, in which a trocar is concealed; the canula is to rest upon the membrana tympani, and the trocar is then to be thrust through the membrane.

The trocar should be so adjusted as not to pass more than  $\frac{1}{8}$  of an inch beyond the canula, to prevent its reaching the opposite side of the cavity of the tympanum. Should it however touch the periosteum of the tympanum, it can be productive of no serious harm. The aperture should be made in the anterior

and inferior part of the membrane; under the manubrium of the malleus, which must not be injured in the operation; and it is therefore necessary that the operator be acquainted with its exact situation.

Though the membrana tympani be vascular, the vessels are so small that they bleed but little; and therefore, if much blood is discharged, the operation cannot have been properly performed.

In an ear otherwise healthy, the operation is attended with so slight a degree of pain, that when it has been performed in one ear, the patient expresses no unwillingness to submitting to it in the other. The sensation which it occasions is momentary; and no subsequent inconvenience of any kind arises.\*

As this operation will not afford relief in any cases of deafness, except such as arise from a closed Eustachian tube, I am anxious that it should be performed in those only which are clearly of that description. The criteria by which I judge whether the tube is closed or open are the following.

First, If the person in whom it is suspected to be closed, should feel, in blowing the nose violently, a swelling in the ear, from the membrane being at that time forced outward, the tube is open; for, when closed, no such sensation is produced.

Secondly, The Eustachian tube may be closed, yet the beating of a watch may be heard, if it be placed between the teeth, or pressed against the side of the head; and, if it cannot be heard when it rests upon the teeth, this operation cannot relieve, as the power of the auditory nerves must have been destroyed.

\* If the ear has been previously irritated by stimulating applications to the meatus, the operation will then be painful; it is therefore proper to wait until the inflammation has subsided.

Thirdly, It is right to inquire if the deafness was immediately preceded by any complaint in the throat.

Lastly, In a closed Eustachian tube there is no noise in the head, like that which is hereafter described as accompanying nervous deafness.

The causes of deafness are extremely numerous; and many of those which affect only the meatus auditorius, the membrana tympani, the cavity of the tympanum, and the Eustachian tube, admit of relief from surgical assistance.

But there is one species of deafness in which, as it depends, like the gutta serena of the eye, upon an affection of the nerve, it would be as absurd to expect relief could be derived from any operation upon the membrana tympani, as it would to suppose that a person diseased in the optic nerve could be restored to sight by extracting the cataract. This species of deafness occurs more frequently than any other, happening generally in old persons; but sometimes also, in the delicate and irritable, in the earlier stages of life; I have known it produced by anxiety and distress of mind. Its approach is generally gradual: the person hears better at one time than at another; a cloudy day, a warm room, agitated spirits, or the operation of fear, produce a considerable diminution in the powers of the organ. In the open air, the hearing is better than in a confined situation; in a noisy, than in a quiet society; in a coach when it is in motion, than when it is still. A pulsation is often felt in the ear; a noise, resembling sometimes the roaring of the sea, and at others the ringing of distant bells, is heard.

This deafness generally begins in a diminished secretion of the wax of the ear, which the patient attributes to some unusual exposure of the head to cold; and this continues so long as the

disease remains. In the commencement of this complaint, it may be cured by the application of such stimulants as are capable of exciting a discharge from the ceruminous glands; which stimulants ought to be introduced into the meatus, for that purpose. If these are used so as to irritate, without exciting a discharge, they are rather prejudicial than otherwise. But, if the organ has been long neglected, and the disease has been suffered to make considerable progress, I believe that no hope of cure can be rationally entertained.\*

There is another cause of deafness, to which I fear no art of the surgeon can apply a remedy; this is, an alteration of the contents of the labyrinth. The interior part of the ear, called the labyrinth, is naturally filled with water, upon which the auditory nerve is expanded; and it is by the undulations of this fluid, that impressions are made upon the nerve, and conveyed to the brain.

If a solid substance be generated in this part of the ear, instead of the fluid, the powers of hearing will be destroyed, or at least very considerably impaired. From the following dissection, this would appear to be at least one cause of deafness in those who are born with this infirmity, and who are also dumb, unless assisted by particular instructions.

Mr. CLINE, being requested by Dr. WALSHMAN, of Kennington, to examine the head of a young man who had died of a fever, and who had been born deaf, and was consequently dumb, found, upon dissecting the organs of hearing, all the parts perfectly formed, and as usual in a healthy ear, except

\* I have, in several cases of this kind, made trial of the operation of opening the membrana tympani, without finding that it afforded any other relief than that of diminishing the noise in the head, which always accompanies it.

the vestibule, cochlea, and semicircular canals ; these were filled with a substance of the consistence of cheese, instead of the fluid which they usually contain. From a defect like this, deafness could not fail to arise ; for, as the substance occupying the place of the watery fluid could not be made to undulate by the motions of the membrane of the fenestra ovalis and rotunda, all impressions upon the auditory nerve were completely prevented.

I have thought it right to describe the foregoing instances of deafness, because they are liable to be confounded with that which arises from a closed Eustachian tube. Others might perhaps have been added ; but various professional engagements have prevented me from devoting so much time to this subject as I am confident it merits. I have, however, the pleasure to reflect, that several individuals have been restored to society, who were before almost incapacitated from its enjoyments. I hope others will be induced, by this success, to second my feeble efforts, and to direct their attention to a subject which appears to be of the highest importance, and to have been too much neglected by medical men ; for a knowledge of the structure of the ear is by no means general in the profession, and still less are its diseases understood. A prejudice has prevailed, that the ear is too delicate an organ to be operated upon, or, as it is commonly express, *tampered with* ; and thousands have thus remained deaf for the rest of their lives, who might have been restored to hearing, had proper assistance been *early* applied. But this prejudice, it is hoped, will now be done away ; since it appears, that the part which has been thought most essential to hearing, viz. the membrana tympani, may be injured by disease, or may be broken by violence, without a deprivation

of the sense of hearing, and that, even when this membrane is entirely destroyed, another is found to perform its functions; so that the powers of the organ have still been, in a considerable degree, preserved.

Let it also be recollected, as a farther encouragement, that in the operation I have mentioned, little pain is felt, no dangerous consequences follow, and, even if it is sometimes performed unsuccessfully, the patient is left with the same capacity as before, of receiving relief from other remedies.

## EXPLANATION OF THE FIGURES. SEE PLATE XXXIII.

Fig. 1. Shews the external ear, the meatus auditorius, membrana tympani, and Eustachian tube.

A, The meatus.

B, The membrana tympani.

C, The cavity of the tympanum.

D, The Eustachian tube.

Fig. 2. Shews the perforating instrument, as it is introduced in the operation.

Fig. 3. The membrana tympani of Mr. G—, of which only that part which appears of a lighter colour remains.

Fig. 4. The membrane lacerated by a blow.

Fig. 5. The membrane lacerated in an attempt to extract a pin.

Fig. 6. Shews the membrana tympani of a medical man in the city, having a fungus projecting through it: in this ear, he is considerably deaf.

Fig. 7. The other membrane of the same gentleman.

Fig. 8. One of the membranes of Mr. P—, whose case I described in my former Paper.

Fig. 9. A membrana tympani in its natural state, shewing the attachment of the manubrium of the malleus.

Fig. 10. The appearance of the membrane after having been punctured.

